

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**



PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification :

C21D 9/56

A1

(11) International Publication Number:

WO 98/38346

(43) International Publication Date:

3 September 1998 (03.09.98)

(21) International Application Number: PCT/GB98/00617

(22) International Filing Date: 26 February 1998 (26.02.98)

(30) Priority Data:

9703957.2

26 February 1997 (26.02.97)

GB

(71) Applicant (for all designated States except US): THE L.S. STARRETT COMPANY [US/US]; 121 Crescent Street, Athol, MA 01331 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): LEE, Andrew, Peter [GB/GB]; 62 Castlegate, Jedburgh, TD8 6DB (GB).

(74) Agents: McCALLUM, William, Potter et al.; Cruikshank &amp; Fairweather, 19 Royal Exchange Square, Glasgow G1 3AE (GB).

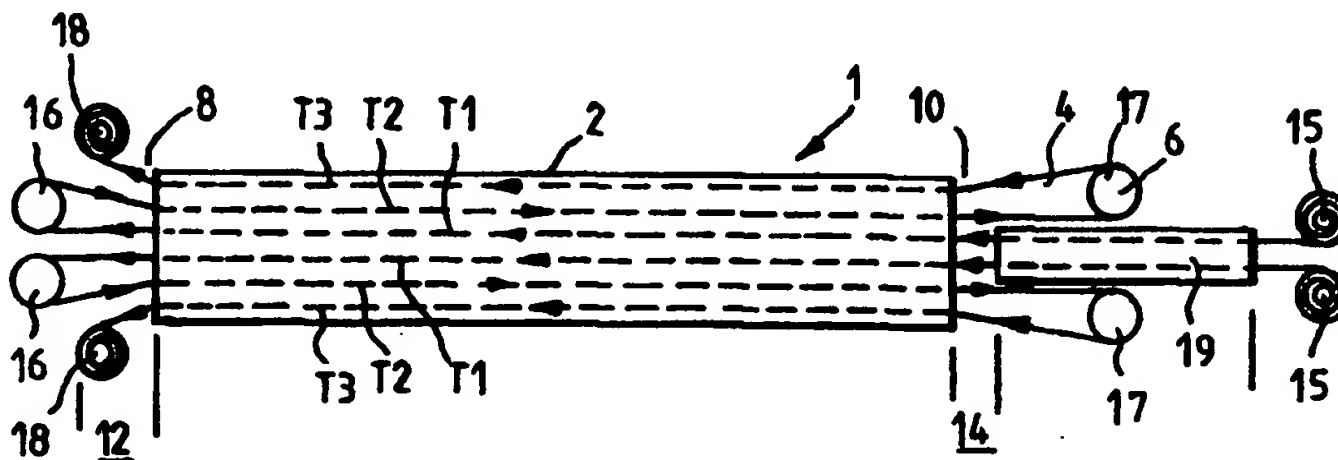
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

## Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND INSTALLATION FOR TEMPERING METALLIC STRIPS



## (57) Abstract

The present invention relates to a tempering system and method for use in the heat treatment of elongate strip material of the type used in for example band saw blades. The apparatus (1) comprises an elongate furnace (2) for heating a continuous length of bi-metal strip (4) held by and transported by a series of rollers (6). At each end (8, 10) of the furnace (2) are quenching zones (12, 14) for cooling rapidly the strip metal (4) as it exits each side of the furnace (2). The rollers are arranged so that a strip of bi-metal held on a supply coil (15) passes through the furnace (2) a first time, through a first quenching zone (12) at one side of the furnace (2) and out of the furnace and into a second quenching zone (14); around a further return roller (17) and back through the furnace (2) for at least a third time. It is then quenched by the quenching zone before being coiled up on a finish coil. The apparatus (1) may be provided with a hardening heating unit (19) placed between the supply coil (15) and the first quenching zone (12) of the system.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## METHOD AND INSTALLATION FOR TEMPERING METALLIC STRIPS

The present invention relates to a tempering system and apparatus for use in the heat treatment of metal materials and in particular elongate strip metal of the type used in  
5 for example band saw blades.

The conventional and known method of heat treating saw blades involves firstly hardening the material at very high temperatures e.g. 1200°C followed by quenching and then  
10 placing in a tempering furnace and soaking at a temperature below the critical temperature e.g. 550°C for a number typically three of predetermined, e.g. two hour periods, each soak being followed by quenching so as to increase the hardness by so-called secondary hardening.

15

The conventional method is essentially a batch process and involves the uncoiling of a typically 500 feet (152.4m) long coil of band saw material and passing this through the first hardening or austenitising process in a continuous flow  
20 process, and then coiling up again into a roll. The coils are then placed in the tempering furnace for tempering and it will be appreciated that in a large roll of material the outside of the roll will reach the desired tempering temperature more quickly than the core portions resulting in  
25 outer portions receiving a longer period at the tempering temperature and thereby uneven tempering of the material and inconsistent results. To seek to overcome this problem the winding on the coil is reversed - "coil reversing".

30 Conventional methods involving "coil reversing" between tempering operations can give rise to chipping of teeth on the band saw.

It is an object of the present invention to avoid or minimize one or more of the foregoing disadvantages.

5 It has now been found that at least equivalent, if not superior, properties and performance of high speed steel (HSS) can be achieved by changing from typically three two hour "soaking" periods at 550/560°C to a similar number of much shorter cycles e.g. 5 mins at somewhat elevated  
10 tempering temperatures which are somewhat higher than conventional tempering temperatures e.g. in the range of 550-600°C, with each heating stage being followed by quenching, in a continuous process tempering of elongate strip material such as band saw blades.

15

Thus the present invention provides a tempering system for use in the heat treatment of elongate strip metal, which system comprises material heating means formed and arranged for heating material to be treated to a tempering temperature  
20 in a heating zone thereof; material quenching means for cooling material heated to said tempering temperature; and material transport means for conveying substantially continuously a substantially continuous elongate length of said material to be heat treated sequentially through said  
25 heating zone and said material quenching means, so that said material is heated to said tempering temperature for a predetermined tempering period as it passes through said heating means and is substantially cooled and hardened upon passing through said quenching means.

30

Thus with a tempering system according to the present invention a very long length of elongate strip material may

be rapidly and safely tempered in a substantially continuous "in-line" process. Advantageously the tempering system of the invention is formed and arranged so as to provide at least two tempering cycles, for example by providing a series of successive tempering heating zones and quenching means or by recycling the strip one or more times through a single tempering heating zone and quenching means.

Preferably said tempering system is coupled in-line with a hardening system having a material hardening heating means for heating said material to a hardening temperature; said hardening heating means and said tempering system being spaced apart by a quenching zone; whereby said material to be treated passes from said hardening heating means via said quenching zone to said tempering heating zone of said tempering system.

The hardening heating means is formed and arranged to heat strip metal passing therethrough to a substantially elevated temperature above the critical temperature of the metal so as to transform the metallurgy of the metal to austenite.

Preferably said tempering temperature is any temperature below the critical temperature, that is the temperature at which there is a change in the metallurgical structure so that the retained austenite in the material is transformed to martensite. Preferably the tempering temperature for use with the system according to the invention is in the range of 550° to 650°C, desirably 580-610°C. The hardening temperature is preferably in the range of 1100 to 1200°C desirably 1150-1190°C.

Desirably said material transport means of said tempering system is formed and arranged with a material transport means of said hardening means so that material passes through said 5 hardening means first and once only before entering the tempering system.

Preferably metal material, having been first heated in said hardening heating means and quenched in said quenching zone 10 between said hardening heating means and said material heating means passes through said tempering heating zone at least twice, desirably three though it may be passed up to six times depending on material mass and size and is quenched after each successive pass therethrough.

15

Preferably said tempering heating zone of said material heating means comprises a single elongate furnace means provided, at each end thereof, with a quenching zone of said quenching means and material transport return means for 20 recycling material exiting a said end of said tempering heating zone and quenched in said quenching zone, back into the tempering heating zone of said tempering heating means, whereby said successive passes through said tempering heating zone and exposure to said tempering temperature and rapid 25 cooling by quenching in said quenching zone cause said material to exhibit secondary or precipitation hardening.

Preferably said material transport means comprises at least one of material pull through apparatus; turntable; wind up 30 system; coiling and uncoiling apparatus and a plurality of roller guides formed and arranged for guiding metal material to be treated held in an untreated coiled form through said

respective hardening, tempering and quenching zones and into a second treated coiled form. Desirably said material transport means and said heating means and quenching means is formed and arranged so that two lengths of elongate strip metal may be processed more or less continuously and simultaneously in side-by-side, parallel relation.

Generally the tempering furnace means has a length of approximately 40 to 50 feet (12-15m) though longer or shorter furnace means may be used depending inter alia on the strip transport speeds used and tempering heating zone residence requirements.

Said tempering heating zone of said material heating means is preferably formed and arranged to heat material to be treated up to a temperature in the range of 550 to 650°C. Said material transportation means is preferably formed and arranged for exposing said material to be treated to said tempering temperature in said tempering heating zone of said material heating means for a period of time of from four to thirty minutes, desirably five to 15 minutes depending on material mass and size, during the or each passage therethrough.

Preferably said quenching means are formed and arranged for cooling rapidly material exiting said tempering zone to a generally ambient temperature. Any suitable type of quenching means known in the general state of the art, such as water, oil or blasted chilled air, may be used.

30

In another respect the present invention provides a method of



tempering continuous extended lengths of strip metal comprising the steps of subjecting said strip metal to at least one, preferably two, tempering cycle, each said tempering cycle comprising feeding said strip metal through a  
5 tempering furnace in a substantially extended form, for a short period of time at an elevated tempering temperature, sufficient for tempering said strip metal without softening thereof, and then through a quenching means.

10 In a further respect the present invention provides a method of heat treating elongate strip metal, so as to increase its hardness which method comprises the steps of:  
providing a tempering system according to the invention;  
passing said material more or less continuously through said  
15 material heating means and said quenching means sequentially by said material transport means so that said material is heated to a tempering temperature for a more or less predetermined period of time and cooled more or less rapidly.

20 Preferably said method includes an additional first step prior to heating to said tempering temperature of heating to a substantially elevated hardening temperature and quenching.

Further preferred features and advantages of the present  
25 invention will appear from the following detailed description given by way of example of a preferred embodiment illustrated with reference to the accompanying drawings in which:-

Fig. 1 is a schematic diagram showing a band saw strip hardening and tempering system according to the present  
30 invention;

Fig. 2 is a graph showing the temperature profile for a length of material tempered by the tempering system shown

schematically in Fig. 1;

Fig. 3 shows a series of photomicrographs illustrating the microstructure of band saw blade strip treated by the system; and

5 Fig. 4 and 5 are graphs showing comparatively the performance data of band saw blades treated by the system.

A hardening and tempering system and apparatus for use in the heat treatment of band saw blades is shown in Fig. 1 and  
10 referred to by reference number 1. The apparatus 1 comprises a furnace 2 for heating a continuous length of bi-metal strip 4 (27mm x 0.9mm M42 metal) held by and transported by a series of rollers 6. At each end 8, 10 of the furnace 2 are quenching zones 12, 14 for cooling rapidly the strip metal 4  
15 as it exits each side of the furnace 2.

The rollers are arranged so that a strip of elongate bi-metal strip 4 held on a supply coil 15 passes through the furnace 2 a first time, indicated by reference T1, through the left  
20 hand quenching zone 12 at the left hand side 8 of the furnace 2, around a return roller 16 and back into the furnace (indicated by T2) and out of the furnace 2 into a right hand quenching zone 14; around a further return roller 17 and back through the furnace 2 for a third time (indicated by T3) and  
25 is then quenched by the left hand quenching zone 12 before being coiled up on a finish coil 18.

The furnace 2 has a length of 50 feet and the apparatus is arranged to process coils of bi-metal strip upto 500 feet  
30 (152m) long.

The apparatus 1 is provided with a hardening heating unit 19, placed between the supply coil 15 and the right hand quenching zone 14 of the system. The hardening unit 19 comprises a furnace which heats the strip metal rapidly to an austenitising temperature of 1180°C. The strip metal is quenched in the right hand quenching zone 14 so that it is cooled very rapidly so that martensite is formed in the metal structure and the metal is hardened. The subsequent passes through the furnace are done at a tempering temperature of 590°C. The time any given section of strip material is held at the tempering temperature in the furnace is five minutes and is determined by the speed at which the bi-metal strip is passed through the furnace 2.

The graph shown in Fig. 2 shows a temperature/distance profile for the apparatus shown in Fig. 1. Examples of typical operational parameters for the system are given below in Table 1.

20

**TABLE 1**

Size	Speed*	Temp (°C)	Soak Time
(mm)	(ins/min) (m/min)		
<27.5 x 0.9	80"/min (2m/min)	590°	5 mins
41.5 x 1.1	37"/min (0.94m/min)	575°	10.8 mins
67.5 x 1.6	18"/min (0.45m/min)	560°	22.2 mins

\* Determined by speed of hardening furnace.

25

Total travel length approx 200ft/61m

Time to pass through will be approx:-

<27.5mm	= 80" per min	6.66 ft/min	2m/min	30 mins
41.5mm	= 37" per min	3 ft/min	0.94m/min	66 mins
5 67.5mm	= 18" per min	1.5 ft/min	0.45m/min	133.3 mins

Fig. 3 shows the five photo micrographs a - e (x 690 magnification) illustrating the optical microstructure produced in M42 bi-metal bandsaw strip resulting from five 10 minute tempering at 590°C of metal strip hardened for 2 minutes at 1180°C and having a grain size (G/S) of 20/22 (Fig. 3a). As will be seen from Fig. 3b-e the microstructure transforms gradually after each successive tempering stage resulting in a microstructure (Fig. 3e) broadly similar to 15 the microstructure of bandsaw strip (Fig. 3f) tempered by using known conventional process.

Fig. 4 is a graph showing the performance data for M42 bi-metal bandsaw blade of cutting time against number of cuts 20 comparing a standard blade heat treated using conventional technique (STD H/T) and blades of the invention. It will be seen that blades having three and four tempering soaks of five minutes at 590°C have improved performance over blades tempered conventionally (indicated by STD H/T).

25

Fig. 5 shows a life comparison (indicated by the number of cuts) of blades treated using different numbers of soak times and length of soak times compared against conventionally heat treated materials (STD H/T1 and 2).

30

It will be appreciated that various different hardening speeds will be required by different material widths,

thicknesses, types and various adjustments may be made to the timings and temperatures of the embodiment described herein above without departing from the scope of the present invention.

5

An equation known as the tempering parameter equation describes the relationship between the temperature and time for tempering of steel.

$$P = T(20 + \text{LOG}t)$$

10

where P = the tempering parameter

T = the temperature in absolute degrees (°C plus 273)

t = time in hours.

15 It has been found that a tempering parameter of  $P = 16347$  is required to obtain a constant hardness of 67HRC. By substituting this value into the tempering parameter equation it is possible to calculate the precise temperatures required to accommodate the various tempering times required by  
20 materials having different thicknesses, widths, types etc. This information can also be used to calculate the temperatures that are required by the various different types of widths, thicknesses, types of bandsaw material.

25 Fig. 6 shows the relationship between tempering time (t) and temperature (T) to achieve a constant hardness of HRC67.

Fig. 7 is a graph of temperature against speed (ins/min and m/min) to achieve constant tempering parameter of 16347  
30 (67HRC) for the in-line tempering of M42 bi-metal bandsaw material.

## CLAIMS

1. A tempering system (1) for use in the heat treatment of elongate strip metal (4), which system comprises material heating means (2) formed and arranged for heating material to be treated to a tempering temperature in a heating zone thereof; material quenching means (12,14) for cooling material heated to said tempering temperature; and material transport means (6) for conveying substantially continuously a substantially continuous elongate length of said material to be heat treated sequentially through said heating zone (2) and said material quenching means (12,14), so that said material (4) is heated to said tempering temperature for a predetermined tempering period as it passes through said heating means (2) and is substantially cooled and hardened upon passing through said quenching means (12,14).

2. A tempering system according to claim 1 formed and arranged to provide at least two tempering cycles to an elongate strip metal (4) passing therethrough.

20

3. A tempering system according to claim 1 or claim 2 formed and arranged to provide a series of successive tempering heating zones (2) and quenching means (12,14).

25 4. A tempering system according to any of claims 1 to 3 formed and arranged to recycle said strip (4) one or more times through a single tempering heating zone (2) and quenching means (12,14).

30 5. A tempering system according to any of claims 1 to 4 which is coupled in line with a hardening system (19) having a material hardening heating means for heating said material

to a hardening temperature; said hardening heating means and said tempering system (1) being spaced apart by a quenching zone (14).

5 6. A tempering system according to claim 5 wherein said hardening heating means (19) is formed and arranged to heat strip metal (4) passing therethrough to a substantially elevated temperature above the critical temperature of the metal so as to transform the metallurgy of the metal to  
10 austenite.

7. A tempering system according to any of claims 1 to 6 wherein said tempering temperature is any temperature below the critical temperature where there is a change in the  
15 metallurgical structure of the strip metal whereby retained austenite is transformed to martensite.

8. A tempering system according to any of claims 1 to 7 wherein said tempering temperature is in the range of from  
20 580 to 610°C.

9. A tempering system according to any one of claims 5 to 8 wherein said hardening temperature is in the range of from  
1150 to 1190°C.

25

10. A tempering system according to any one of claims 5 to 9 wherein said material transport means (6) is formed and arranged with a material transport means of said hardening means (19) so that material passes through said hardening  
30 means first and once only before entering the tempering system (1).

11. A tempering system according to any one of claims 5 to 10 wherein said metal material (4) having been first heated in said hardening heating means (19) and quenched in said quenching zone (14) between said hardening heating means (19) and said material heating means (2) passes through said tempering heating zone at least twice.

12. A tempering system according to any of claims 1 to 11 wherein said tempering heating zone (2) of said material heating means comprises a single elongate furnace means (2) provided, at each end (8,10) thereof, with a quenching zone (12,14) of said quenching means and material transport return means (16) for recycling material exiting a said end of said tempering heating zone and quenched in said quenching zone, back into the tempering heating zone of said tempering heating means.

13. A tempering system according to any of claims 5 to 12 wherein said material transport means comprises at least one of material pull through apparatus; turntable; wind up system; coiling and uncoiling apparatus and a plurality of roller guides (6) formed and arranged for guiding metal material to be treated held in an untreated coiled form through said respective hardening, tempering and quenching zones and into a second treated coiled form.

14. A tempering system according to any of claims 1 to 13 wherein said material transport means (6,16), said heating means (2) and quenching means (12) are formed and arranged so that two lengths of elongate strip metal (4) may be processed more or less continuously and simultaneously in side-by-side,



parallel relation.

15. A tempering system according to any of claims 1 to 14 wherein said tempering heating zone of said material means is 5 formed and arranged to heat material to be treated up to a temperature in the range of from 550 to 650°C.

16. A tempering system according to any of claims 1 to 15 wherein said material transportation means (6,16) is formed 10 and arranged for exposing said material to be treated to said tempering temperature in said tempering heating zone (2) of said material heating means for a period of time of from 4 to 30 minutes during the or each passage therethrough.

15 17. A tempering system according to any of claims 1 to 16 wherein said quenching means (12,14) are formed and arranged for cooling rapidly material exiting said tempering zone to a generally ambient temperature, said quenching means being selected from the group including water, oil or blast chilled 20 air.

18. A method of tempering continuous extended lengths of strip metal (4) comprising the steps of subjecting said strip metal to at least one tempering cycle, each said tempering 25 cycle comprising feeding said strip metal through a tempering furnace (2) in a substantially extended form, for a short period of time at an elevated tempering temperature, sufficient for tempering said strip metal without softening thereof, and then through a quenching means (12).

30

19. A method according to claim 18 wherein said strip metal is subjected to a plurality of tempering cycles.

20. A method of heat treating elongate strip metal, so as to increase its hardness which method comprises the steps of: providing a tempering system (1) according to any one of  
5 claims 1 to 17; passing said material (4) more or less continuously through said material heating means (2) and said quenching means (12,14) sequentially by said material transport means (6,16) so that said material is heated to a tempering temperature for a more or less predetermined period  
10 of time and cooled more or less rapidly.

21. A method as claimed in claim 20 which includes an additional first step prior to heating to said tempering temperature of heating to a substantially elevated hardening  
15 temperature and quenching.

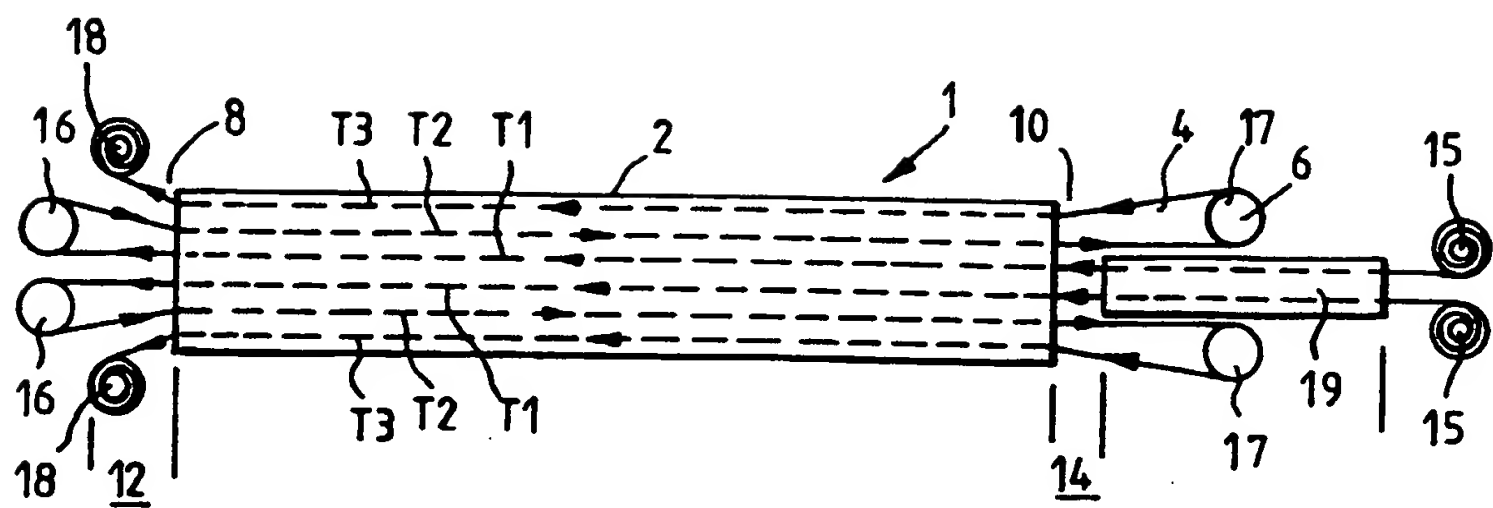


FIG. 1

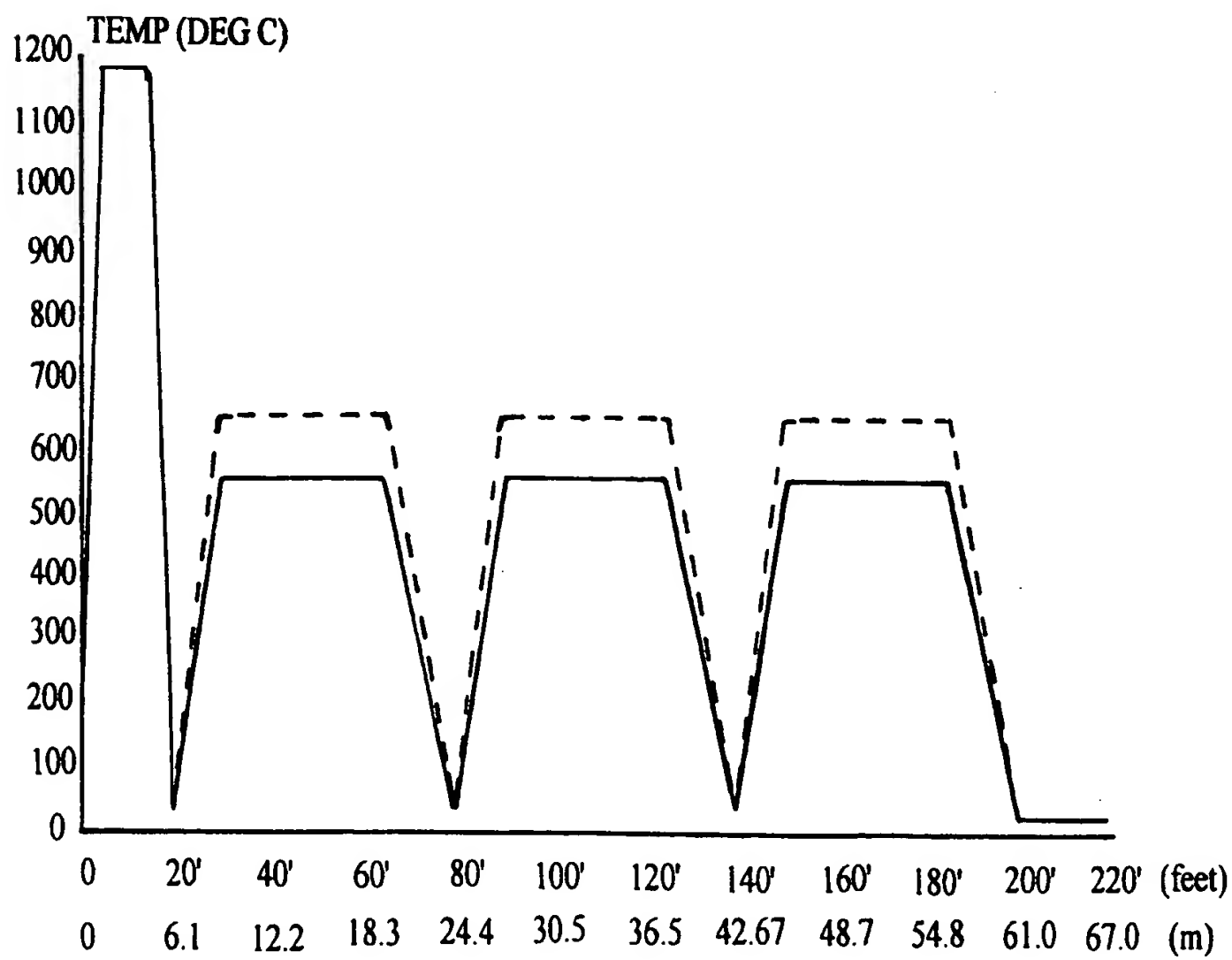


FIG. 2

2/6

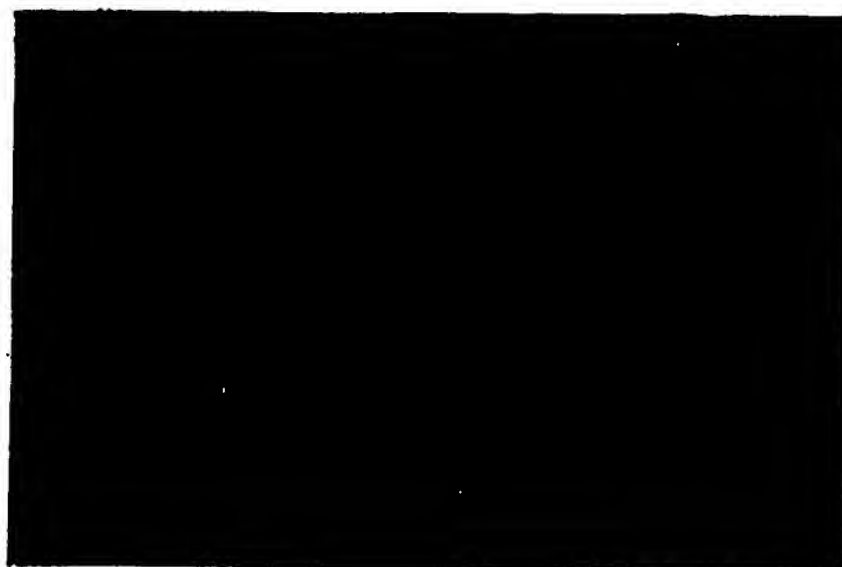
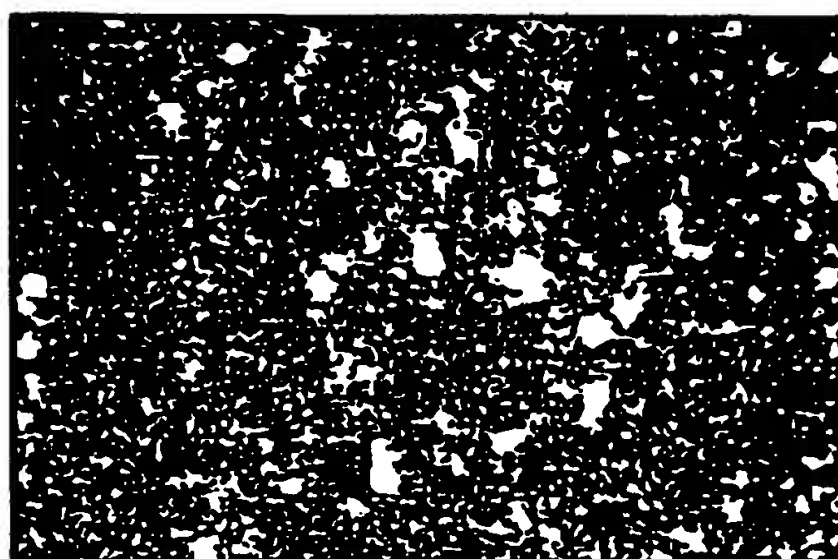


FIG . 3a



1\*TEMPER @ 590C

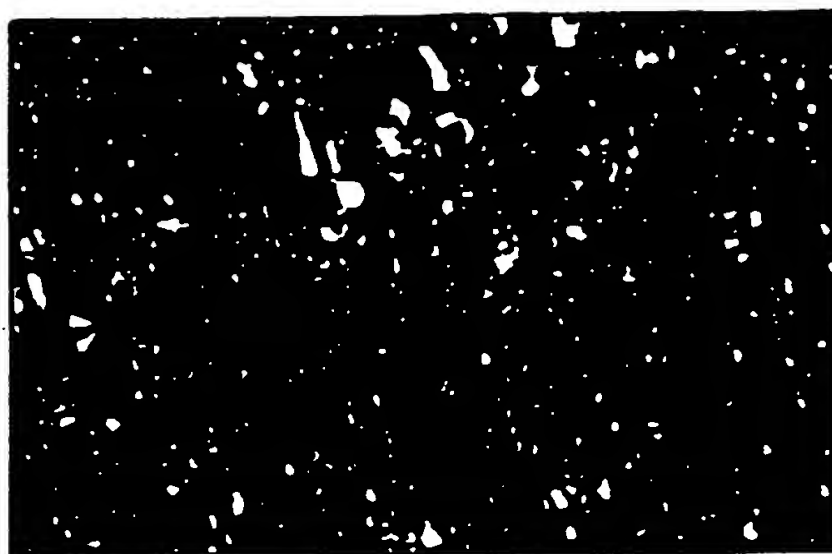
FIG . 3b



2\*TEMPERS @ 590C

FIG . 3c

3/6



3\*TEMPERS @ 590C

FIG .3d



4\*TEMPERS @ 590C

FIG .3e

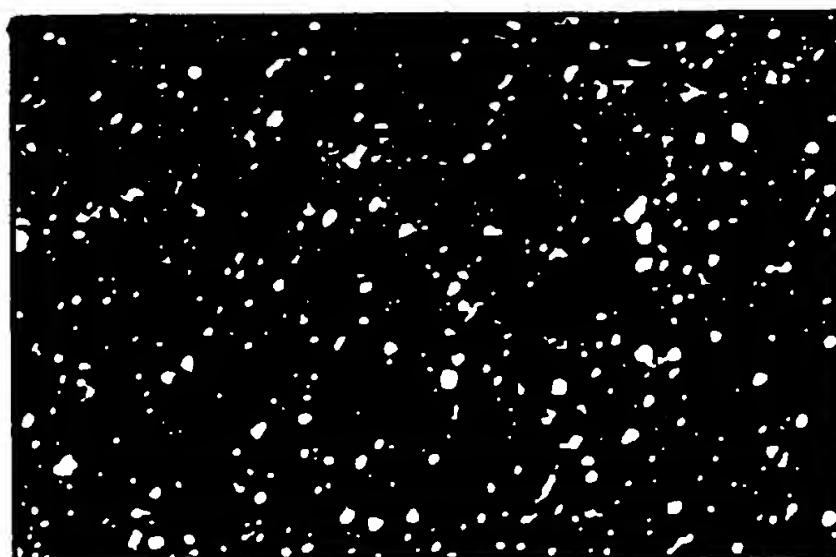


FIG .3f

4/6

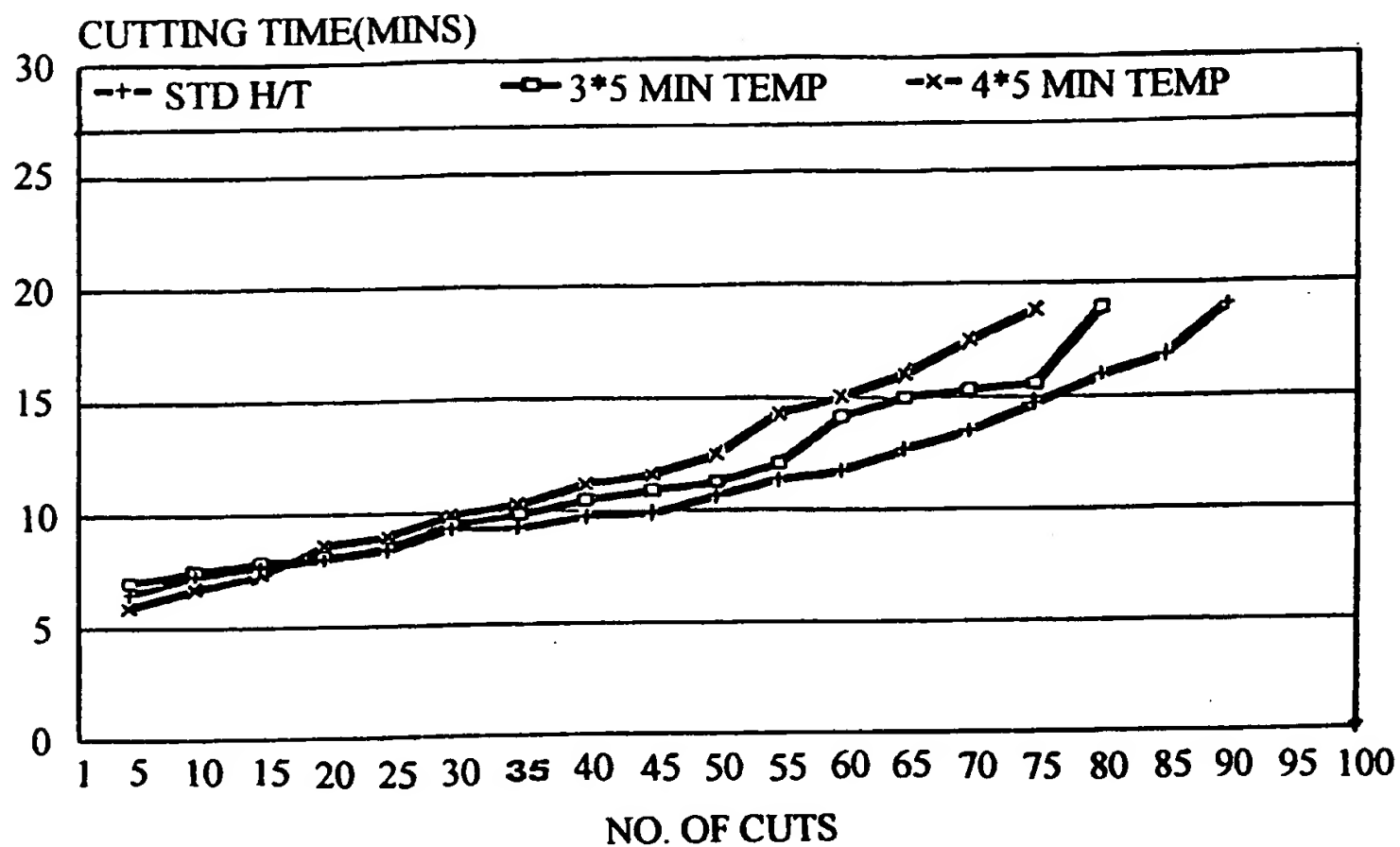


FIG. 4

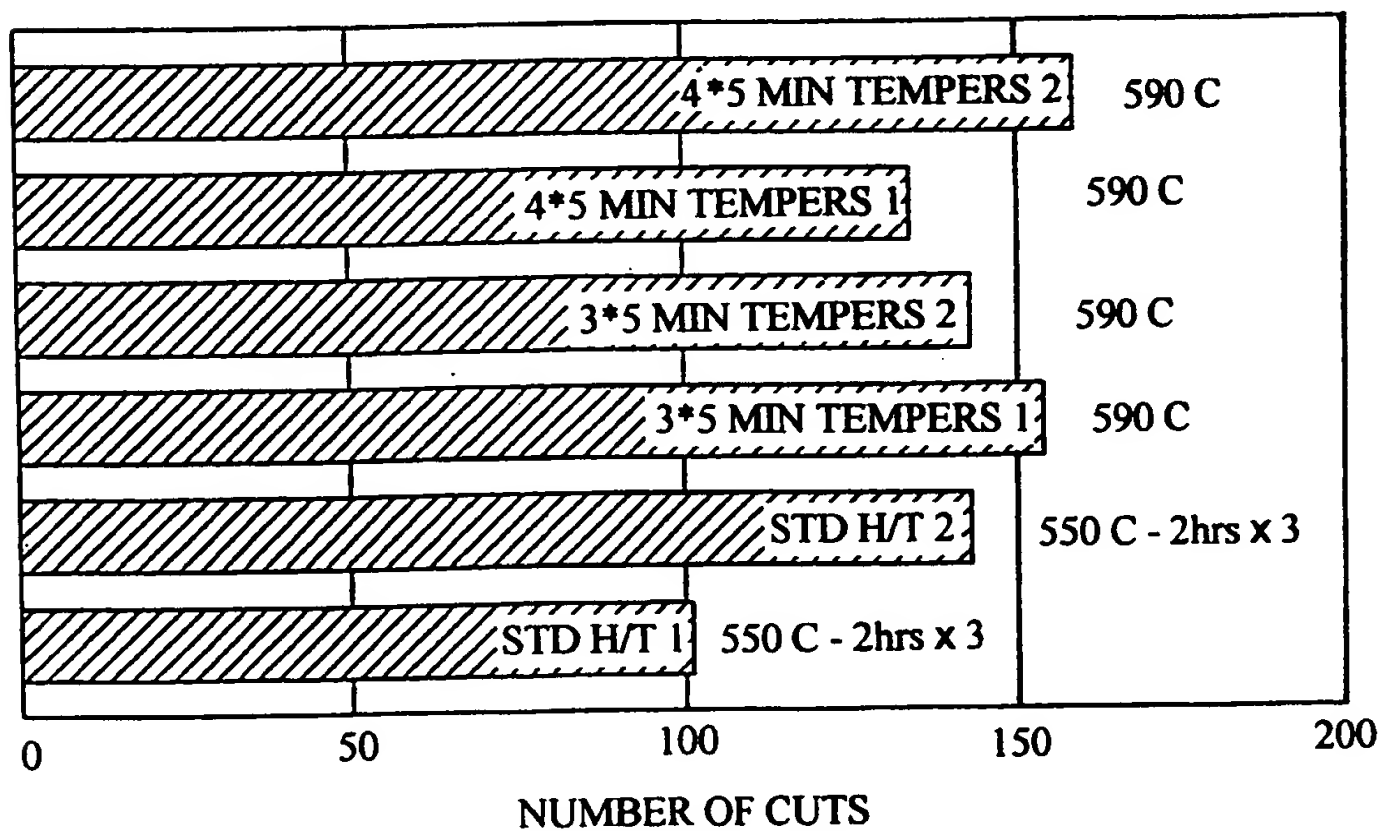


FIG. 5

SHORT-TIME TEMPERING OF M42 BI-METAL BANDSAW  
Relationship between Tempering Time(t) and Temperature(T)  
to achieve constant HRC67

$P = T + 273(20 + \text{LOG } t)$  where  $P = 16347$

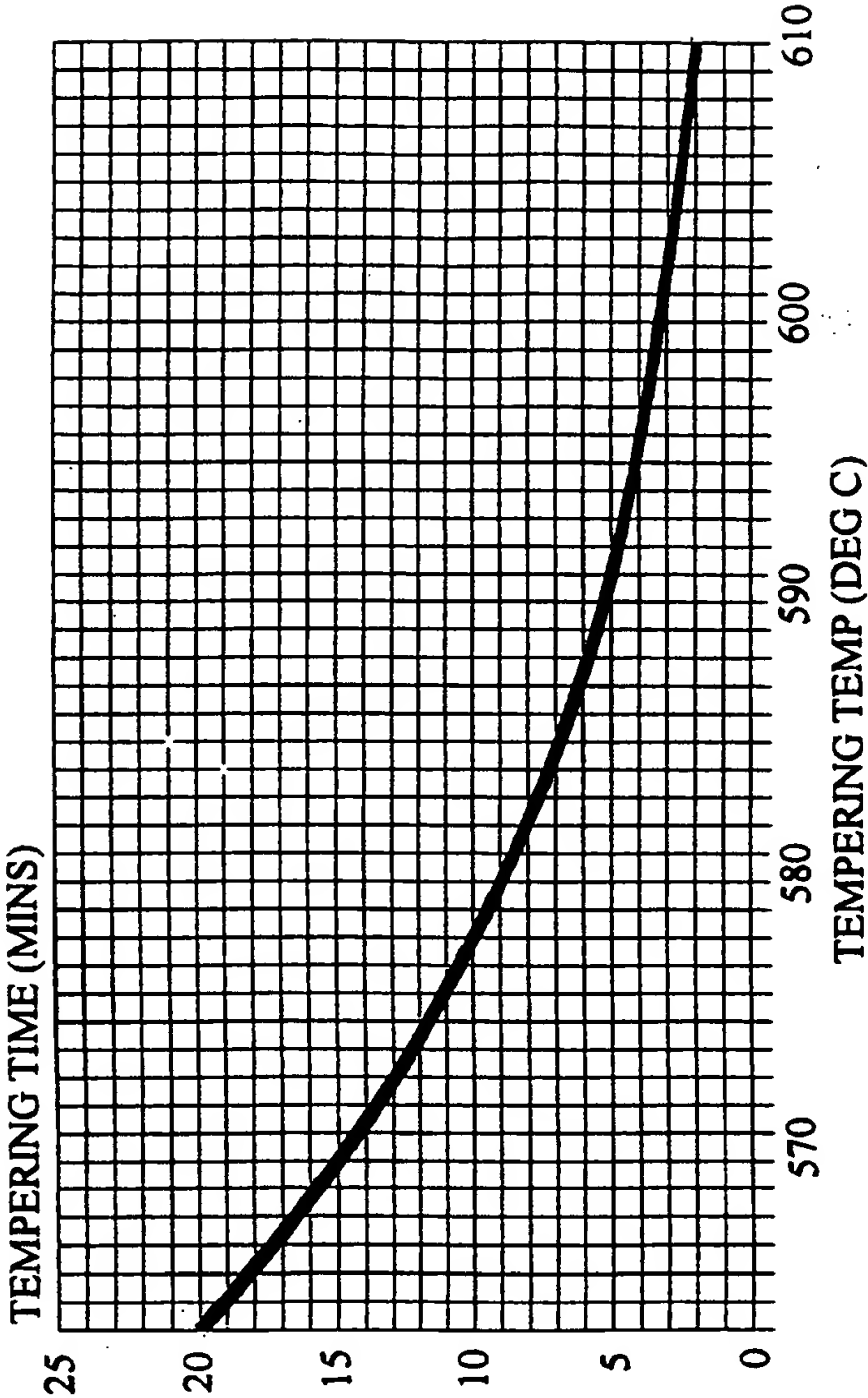


FIG . 6

"IN-LINE" TEMPERING OF M42 BI-METAL BANDSAW  
VARIATION IN TEMPERATURE TO ACHIEVE CONSTANT  
TEMPERING PARAMETER OF 16347 (67 HRC)

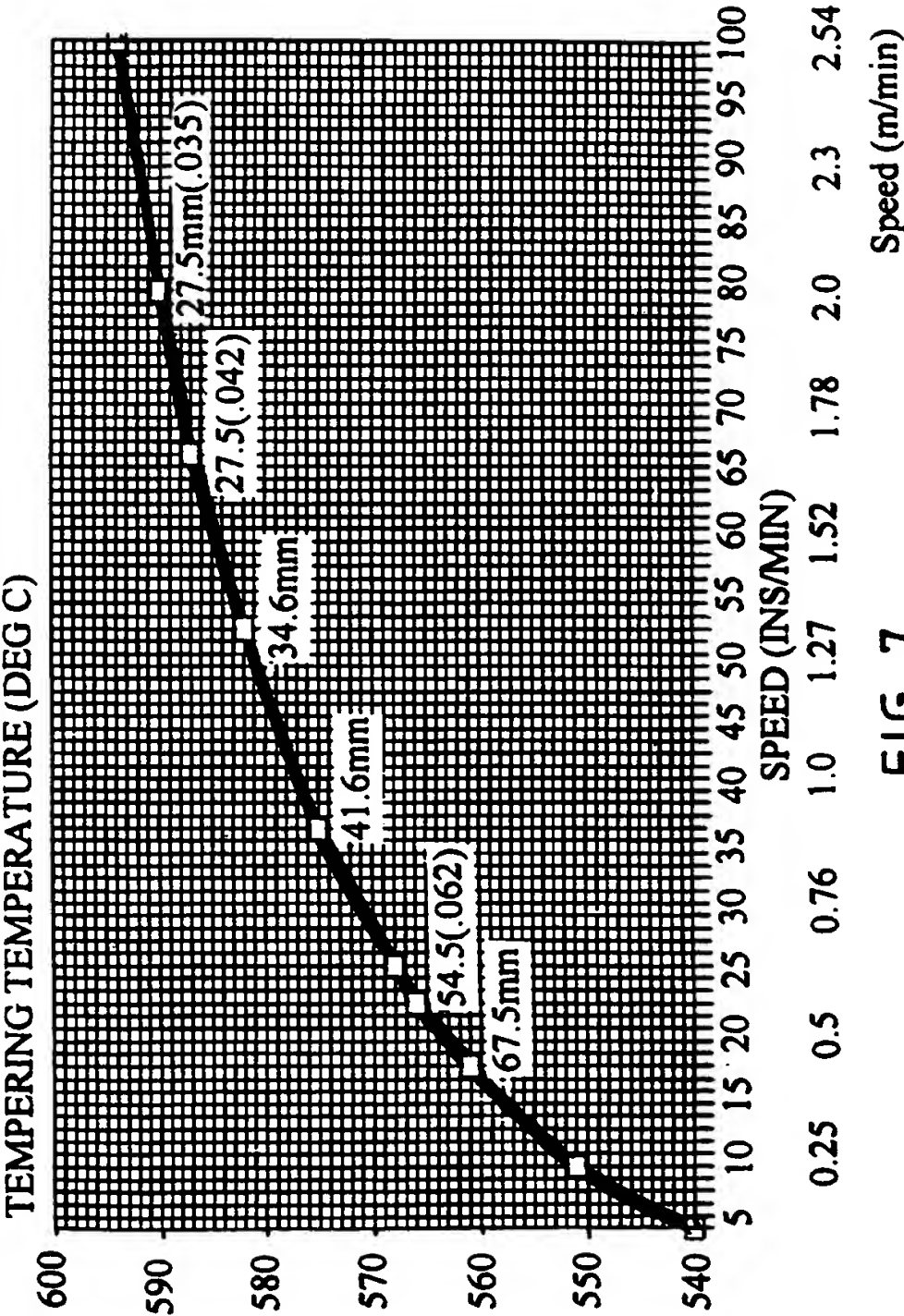


FIG. 7



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/00617

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 C21D9/56

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1 732 244 A (S. I. SALZMAN) 22 October 1929 see claim 1; figure 1	1, 18, 20
A	FR 2 383 235 A (SVENSKA AB ELPHIAC) 6 October 1978 see claim 1; figure 1	1, 18, 20
X	DE 376 421 C (THEODOR VORMANN) 28 May 1923 see claim; figure	1-4
A	DE 334 556 C (CRITCHLEY, SHARP & TETLOW LIMITED ET AL.) 14 March 1921 see claim 1; figure	1-4
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

6 July 1998

Date of mailing of the international search report

20/07/1998

Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Sutor, W

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/00617

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 231 (M-0974), 16 May 1990 & JP 02 059211 A (HITACHI KOKI CO LTD), 28 February 1990, see abstract	8
A	DE 27 53 475 A (UDDEHOLMS AB) 22 June 1978 see page 8, line 8-13	9
A	GB 906 517 A (THE CAPEWELL MANUFACTURING COMPANY) 19 September 1962 see claim 5	8,9,15
A	US 5 417 777 A (W. E. HENDERER) 23 May 1995 see column 3, line 46-57	8,9,15
A	EP 0 319 511 A (BÖHLER GESELLSCHAFT M.B.H.) 7 June 1989 see page 4; table 4	8
A	US 4 321 098 A (H. A. HAYDEN) 23 March 1982 see claim 1; figures 1,2	1
A	C. W. WEGST: "Stahlschlüssel", VERLAG STAHLSCHLÜSSEL WEGST GMBH, MARBACH, DE, 15TH ENLARGED EDITION, 1989 XP002070465 see page 193-194 (Standard no. 1.3247) and 250 ( AISI M 42 )	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 98/00617

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 1732244	A	22-10-1929	NONE		
FR 2383235	A	06-10-1978	NONE		
DE 376421	C		NONE		
DE 334556	C		NONE		
DE 2753475	A	22-06-1978	SE	419101 B	13-07-1981
			AT	376705 B	27-12-1984
			FR	2374159 A	13-07-1978
			GB	1547520 A	20-06-1979
			JP	53102215 A	06-09-1978
			SE	7614267 A	18-06-1978
			US	4232096 A	04-11-1980
GB 906517	A		NONE		
US 5417777	A	23-05-1995	CA	2167832 A	24-08-1995
			EP	0715658 A	12-06-1996
			WO	9522633 A	24-08-1995
EP 319511	A	07-06-1989	AT	391826 B	10-12-1990
			DE	3864393 A	26-09-1991
			JP	1201437 A	14-08-1989
			US	5015539 A	14-05-1991
			US	5091264 A	25-02-1992
US 4321098	A	23-03-1982	NONE		

*Examiner's Copy*

AN 120:82919 HCA  
TI Manufacture of high-tensile **steel** strip by **rapid**  
**tempering**  
IN Chijiiwa, Rikio; Tamehiro, Hiroshi; Tsuruta, Tosha; Fujioka, Masaaki  
PA Nippon Steel Corp, Japan  
SO Jpn. Kokai Tokkyo Koho, 6 pp.  
CODEN: JKXXAF  
DT Patent  
LA Japanese  
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
	-----	----	-----	-----	-----
PI	JP 05255743	A2	19931005	JP 1992-50890	19920309
AB	A <b>steel</b> contg. C 0.02-0.20, Si .ltoreq.1, Mn 0.5-2.0, P .ltoreq.0.020, S .ltoreq.0.010, Al .ltoreq.0.05, and N .ltoreq.0.008% after rolling is (a) directly quenched or (b) air-cooled to normal temp., post-heated, and quenched to give a <b>steel</b> strip having mixed microstructure of bainite and martensite. The strip is placed in a furnace at 800-1000.degree., heated at .gtoreq.0.2.degree./s until the surface temp. becomes (A1 - 200.degree.)-(A1 + 100.degree.), immediately removed from the furnace, and cooled at .gtoreq.2.degree./s. The strip has high toughness and is manufd. at low cost.				

AN 1988-351938 [49] WPIDS  
DNN N1988-266549 DNC C1988-156020  
TI Cylindrical **steel** item heat treatment - involves heating for  
**tempering**, at increasing **tempering** temp. so that equal-  
**temp. zones** form spiral line.  
DC M24 X25  
IN BUKANIN, V A; DEDULYA, I I; PROSTYAKOV, P A  
PA (ELEC-R) ELETROTHERMAL EQUIP  
CYC 1  
PI SU 1397506 A 19880523 (198849)\* 3p  
ADT SU 1397506 A SU 1986-4173814 19861231  
PRAI SU 1986-4173814 19861231  
AB SU 1397506 A UPAB: 19930923  
The process comprises hardening by induction heating to 840-930 deg. C.  
and **tempering** in **zones**.  
The heating for termpering is done with temp. increasing at the  
perimeter of the cross section, from low **tempering** tem. to high  
**tempering** temp., in such a manner that the **zones** heated  
to equal temp. form spiral lines on the side surface of the cylinder.  
ADVANTAGE - Improved durability of items subjected to torsional and  
bending deformation and shock loads. The surface acquires damping spring  
properties. Time to onset of fatigue cracks is increased by 8-10%.  
Bul.19/23.5.88.

AN 1999-439939 [37] WPIDS

DNC C1999-129908

TI Continuous **steel** strip welded section annealing process for continuous annealing installation - involves annealing by **radiation** and convection heat from burner provided with permeable member consisting of sintered ceramics laminated with sintered metal alloy or refractories.

DC M12 M24

PA (NISI) NISSHIN STEEL CO LTD

CYC 1

PI JP 11181528 A 19990706 (199937)\* 5p

ADT JP 11181528 A JP 1997-363873 19971218

PRAI JP 1997-363873 19971218

AB JP 11181528 A UPAB: 19990914

NOVELTY - A permeable member (62) which consists of sintered ceramics laminated with sintered metal alloy or refractories is provided on the combustion burner (60) arranged individually to either sides of welded section of **steel** strip (1). The annealing of strip welded section is performed by **radiation** and convection heat.

USE - Used for annealing of welded section of **steel** strip, in continuous annealing or pickling installation, etc.

ADVANTAGE - The variation in **tempering** of the welded section of **steel** strip is eliminated because it is heated uniformly. The joining strength is improved and fracture is prevented. The combustion temperature is controlled easily since gas of uniform calories is supplied to the burner. DESCRIPTION OF DRAWING(S) - The figure shows block diagram of anneal installation. (1) **Steel** strip; (60) Combustion burner; (62) Permeable member.

Dwg.2/5

*Examiner's Copy*

AN 91:60966 HCA  
TI Structure and properties of **steels** 16G2 and 16GFR after  
quenching and **short-term tempering**  
AU Frantov, I. I.; Karchevskaya, N. I.; Golovanenko, S. A.; Rudchenko, A. V.  
CS Tsent. Nauchno-Issled. Inst. Chern. Metall., Moscow, USSR  
SO Metalloved. Term. Obrab. Met. (1979), (5), 51-3  
CODEN: MTOMAX; ISSN: 0026-0819  
DT Journal  
LA Russian  
AB **Steels** 16G2 [66776-06-5] and 16GFR [65803-95-4] were quenched  
at 15-100.degree./s and tempered after heating to 640-720.degree. at  
1-2.degree./s without isothermal holding. The formation of a polygonized  
martensite [12173-93-2] in 16GFR during high-speed quenching provided  
improved mech. properties: tensile strength 65-70 kg/mm2 and -45.degree.  
impact toughness 5.0 kg-m/cm2. The coalescence of carbides in 16GFR  
occurred to a greater extent than in 16G2.